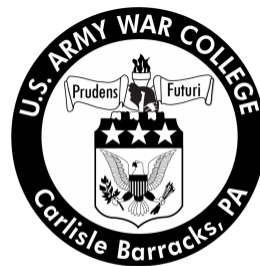


Army Water Sustainment: An Analysis of Capabilities and Capacities

by

Colonel Thomas P. Murphy
United States Army



United States Army War College
Class of 2012

DISTRIBUTION STATEMENT: A

Approved for Public Release Distribution
is Unlimited

This manuscript is submitted in partial fulfillment of the requirements of the Master of Strategic Studies Degree. The views expressed in this student academic research paper are those of the author and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.

The U.S. Army War College is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, PA 19104, (215) 662-5606. The Commission on Higher Education is an institutional accrediting agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation.

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 22-03-2012		2. REPORT TYPE Strategy Research Project		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE Army Water Sustainment: An Analysis of Capabilities and Capacities				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Colonel Thomas P. Murphy				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Colonel James Scudieri Department of Military Strategy, Planning, and Operations				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army War College 122 Forbes Avenue Carlisle, PA 17013				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Distribution A: Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT For the Army, access to water is fundamental to ensure unit readiness and preparedness to execute effective combat operations. Clean, potable water enables commanders to achieve military success in support of campaign and political objectives. Planners in general and logisticians specifically, at every level, must understand and analyze the Army's capability and capacity to purify and distribute water, in order to implement the Tenets of Unified Land Operations successfully. The intent of planning water purification and distribution operations is to determine if the Army can meet and sustain its forces' water requirements during contingency operations effectively in anticipated, austere environments. Such capabilities are critical to enable the Army to perform its two core competencies of combined arms maneuver and wide area security. This paper offers an analysis of the Army's Active Component (AC) and Reserve Component (RC) current water purification and distribution capabilities and capacities; examines the Army's shortfalls in water support; and recommends steps to alleviate these shortfalls.					
15. SUBJECT TERMS water production, water purification, contingency, distribution based logistics					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UNLIMITED	18. NUMBER OF PAGES 34	19a. NAME OF RESPONSIBLE PERSON
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code)

USAWC STRATEGY RESEARCH PROJECT

**ARMY WATER SUSTAINMENT:
AN ANALYSIS OF CAPABILITIES AND CAPACITIES**

by

Colonel Thomas P. Murphy
United States Army

Colonel James Scudieri
Project Adviser

This SRP is submitted in partial fulfillment of the requirements of the Master of Strategic Studies Degree. The U.S. Army War College is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, PA 19104, (215) 662-5606. The Commission on Higher Education is an institutional accrediting agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation.

The views expressed in this student academic research paper are those of the author and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.

U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

ABSTRACT

AUTHOR: Colonel Thomas P. Murphy

TITLE: Army Water Sustainment: An Analysis of Capabilities and Capacities

FORMAT: Strategy Research Project

DATE: 22 March 2012 WORD COUNT: 6,060 PAGES: 34

KEY TERMS: Water Production, Water Purification, Contingency, Distribution Based Logistics

CLASSIFICATION: Unclassified

For the Army, access to water is fundamental to ensure unit readiness and preparedness to execute effective combat operations. Clean, potable water enables commanders to achieve military success in support of campaign and political objectives. Planners in general and logisticians specifically, at every level, must understand and analyze the Army's capability and capacity to purify and distribute water, in order to implement the Tenets of Unified Land Operations successfully. The intent of planning water purification and distribution operations is to determine if the Army can meet and sustain its forces' water requirements during contingency operations effectively in anticipated, austere environments. Such capabilities are critical to enable the Army to perform its two core competencies of combined arms maneuver and wide area security. This paper offers an analysis of the Army's Active Component (AC) and Reserve Component (RC) current water purification and distribution capabilities and capacities; examines the Army's shortfalls in water support; and recommends steps to alleviate these shortfalls.

ARMY WATER SUSTAINMENT: AN ANALYSIS OF CAPABILITIES AND CAPACITIES

Unless potable water is continuously provided, soldiers will seek local sources, which are usually contaminated by petroleum oils and lubricants (POL) runoff, sewage, bacteria, or unburied corpses.¹

—FM 3-06.11, February 28, 2002

The quote above, from FM 3-06.11, *Combined Arms Operations in Urban Terrain*, with the exception of the reference to POL runoff, which is unique to modern warfare, is true of all conflict in human history. For the Army, clean, potable water ensures readiness and preparedness to execute effective combat operations, enabling commanders to achieve military success and the strategic end state. Without it, the Army is unable to conduct sustained operations, resulting in military and political failure.

This strategy research paper analyzes the Army's water production and distribution capabilities, capacity and doctrinal processes from Brigade Combat Team (BCT) through echelons above brigade (EAB) levels. The intent is to determine if the Army can meet and sustain its forces' water requirements during contingency operations effectively in an austere theater.

Such capabilities are key to enable the Army to perform its two core competencies of combined arms maneuver and wide area security through the execution of its six war fighting functions, of which the fifth is sustainment.² The production and distribution of potable water is a critical supply and service, requiring detailed and integrated planning of every stage. In order to accomplish this level of detailed planning, sustainment leaders and planners must first understand the physical

and operational environment, because “bulk water is still foraged on the modern battlefield.”³

The Environment

Only three percent of the world’s water resources are fresh water and only one percent of this water is readily available for consumption, agriculture, and industry. The remaining two percent is icebound in the polar ice-caps or in deep-ground water aquifers and inaccessible. Consequently, the world relies upon precipitation, rivers, streams and swamps as sources for fresh water, with rivers being the primary source.⁴

The other ninety-seven percent is the world’s salt water oceans. This water is possible to desalinize. However, desalinization requires “large amounts of energy as well as specialized, expensive infrastructure, making it very costly” to produce as a viable source of water.⁵ Thus, fresh water scarcity, especially in the Middle East, Africa, and South Central Asia could have significant impact on regional and international stability, negatively affecting United States national security and economic interests.

Political realities compound the challenges. Failed States in Africa, such as Somalia, where access to fresh water and the drought has had significant impact on stability, have become safe havens for terrorist and criminal elements that pose a direct threat to American security. In Asia, “the nation’s strategic priorities and interests will increasingly emanate from the Asia-Pacific region.”⁶ The Middle East, Africa and Asia-Pacific regions have considerable water scarcity and the Middle East and Africa are arid environments.

The Army must enable current and future forces to operate in arid and water-depleted environments. The Army should also apply the lessons learned from the last

ten years of conflict in an arid environment to its current doctrine. The Army must also prepare to conduct operations in an austere, arid environment with little to no host-nation support or viable infrastructure. This environment consists of “over populated megacities with a young population willing to use violence to achieve goals.”⁷ Its arid nature requires increased water consumption, production and distribution to sustain army forces. The availability of water sources, viable lines of communications (LOC), and the ability of sustainment forces to defend themselves against hybrid threats become critical planning factors for logistics planners.

Doctrine

Hybrid threats and battlefield geometry pose the greatest impediment to successful sustainment operations. Hybrid threats are a combination of regular, irregular, and terrorist forces, as well as criminal elements that operate within the local population.⁸ The battlefield itself will be non-contiguous with extended LOCs that are subject to interdiction, requiring sustainment forces to use internal assets for self defense, often coined in the field as self-securing. Defense against the hybrid threat enables the sustainment of “Army Forces in austere environments, often at the ends of extended LOCs . . . [with a] logistics network capable of projecting and providing the support and services necessary to ensure freedom of action, extend operational reach, and prolong endurance.”⁹

Army logisticians provide the support and services to sustain “Unified Land Operations” where “Army units seize, retain, and exploit the initiative to gain and maintain a position of relative advantage in sustained land operations to create conditions for favorable conflict resolution.”¹⁰ Unified Land Operations consists of the two core competencies of combined arms maneuver and wide area security.”¹¹ Both of

these core competencies will consist of offensive, defensive, and stability and support operations simultaneously. Sustainment determines their depth, duration and endurance.¹²

Army logisticians sustain combined arms maneuver and wide area security through the application of distribution based logistics (DBL). Rather than build large stockpiles of supply and support bases to sustain combat operations, DBL enables the Army to reduce its logistics footprint by establishing a distribution pipeline that provides frequent and reliable distribution of supply and services and continuous, metered flow of logistics to using units.¹³ TRADOC PAM 525-4-1, *The United States Army Functional Concept for Sustainment: 2016-2028*, further defines DBL as:

“Distributed support and sustainment is the capability to provide supplies, personnel, and equipment to decentralized forces across non-contiguous locations, over any distance, and in any combination of offensive, defensive, stability and/or civil support operations to maintain readiness and ensure the freedom of action of the joint forces.”¹⁴

Significantly, the Army is also, the joint force executive agent for the “management of land-based water resources in support of contingency operations.”¹⁵ As such, the Army is responsible to establish doctrine, training, and execution of all land-based water operations for the joint force.¹⁶ The primary doctrine for army water support operations are Field Manuals 10-52 and 10-52-1.

Field Manual 10-52, *Water Supply in Theaters of Operations* published July 11, 1990 and is based on Air Land Battle doctrine. As a result, it is in great need of an update and inclusion of lessons learned from the last ten years of conflict in an arid environment. The basic theory of water operations, in this field manual, is “water supply is provided on an area basis by Quartermaster Combat Service Support units using

supply point distribution.”¹⁷ Under the emerging DBL doctrine water is produced and distributed “as close to the point of use as possible.”¹⁸

Today, the Army has two levels of water production and distribution. The first is at the Brigade Combat Team (BCT) and Multi-Functional Brigade, in which the Brigade Support Battalion’s (BSB) Supply and Distribution Company provides water production, storage and distribution to the Brigade’s subordinate battalions. The second is at Echelons Above Brigade (EAB) level which includes functional brigades, higher level command and control headquarters e.g. Division, Corps, and Theater HQs; and EAB enabling units. The Quartermaster Water Purification and Distribution Company and its subordinate modular production and distribution platoons support EAB units.¹⁹

These two echelons of water production and distribution meet the doctrinal requirement to provide overall water support as close to the point of use as possible. Additionally, the concept significantly reduces the water transportation requirements, especially line-haul requirements, freeing EAB transportation assets to conduct dry-cargo, distribution-based logistics.²⁰ Finally, the Army diminishes its reliance on bottled water as a primary source of water consumption.

Whether using bottled water or bulk potable water is immaterial when planning daily water requirements for the force. FM 10-52, *Water Supply in Theater Operations*, provides a table of planning factors to determine daily water requirements in an arid environment.²¹ There are two planning factors; both compute water requirements in gallons per soldier per day. The first is the “minimum” planning factor, which includes water “enough for a force to survive up to one week.”²² The second is the “sustaining” planning factor which is “requirements exceeding one week.”²³ The arid planning factor

for “minimum” is 6 gallons and “sustaining” operations is 13 gallons.²⁴ All computations for this paper will use the sustaining planning factor.

The sustaining planning factor accounts for the Army and Joint Force to reduce their reliance on bottled water. Bottled water is expensive to produce, package, and distribute on the modern battlefield. Additionally, transportation of bottled water from in-theater sources or from ports of debarkation is an inefficient use of dry-cargo line-haul assets. Such movements negate the doctrinal principle of water support as close to the point of use as possible.

For example, a recent Marine Corps study in Afghanistan found that the cost of using bottled water is \$4.69 per gallon.²⁵ Using this dollar factor, the expense to sustain a standard Infantry Brigade Combat Team (IBCT) with bottled water at the “minimum” planning factor is \$82,075 per day or \$29.9M per year. The cost to produce and distribute a gallon of bulk potable water is estimated at \$1.00 per gallon.²⁶ The expense to sustain the IBCT noted above is \$17,500 per day or \$6.3M per year. In this time of fiscal austerity the Army and Joint Force need to reduce its reliance on bottled water.

The next critical step is to determine if the Army has the requisite capacity within this capability to meet the requirements at the BCT and EAB levels. Additionally, the Army, must be able to provide the backup water-supply support to other joint or coalition forces in theater, as the Army is the Executive Agent for land-based water management.²⁷

The Brigade Combat Team (BCT) and Support Brigades

Modular sustainment organizations provide the logistics support to sustain BCTs and support brigades operations. The BSB in the Infantry Brigade Combat Team (IBCT), Heavy Brigade Combat Team (HBCT), and Stryker Brigade Combat Team

(SBCT) provides the modular logistics support, to include water production, storage, and distribution, required to sustain operations.²⁸

Similarly, the BSB in the Combat Aviation Brigade (CAB), Fires Brigade, and Maneuver Enhancement Brigade (MEB) provides water support to these support brigades.²⁹ However, in Fiscal Year 13 (FY13), the Army plans to inactivate the BSB organizations in the MEB, in support of Army drawdown initiatives.³⁰ The inactivation of the MEB BSB will require the MEB to receive logistics support from the Combat Sustainment Support Battalion (CSSB) of the Sustainment Brigade (SBDE). The Battlefield Surveillance Brigade (BfSB) does not have an organic BSB. The BfSB contains a Brigade Support Company (BSC) that provides water support.³¹

The transformation to modular sustainment organizations of BSBs and BSCs provide BCTs and Support Brigades with organic water production and distribution capabilities previously not available at the brigade level.³² The water generation capability “eliminate[s] traditional supply point operations and replace[s] it with distribution based operations for enhanced integration of logistics into the operational battle rhythm.”³³ Moreover, water production at the brigade level meets the doctrinal intent to “produce water as close to the point of need as possible thereby eliminating the need for bottled water.”³⁴ Each BSB has an organic water section in the fuel and water platoons of its distribution company. The BSC has a water section in its distribution platoon. The water sections provide the capability to produce and store 33K gallons of water per day using the Tactical Water Purification System (TWPS) and Lightweight Water Purifier (LWP).³⁵

However, in the arid, water-scarce operating environment previously outlined, the water production and storage capacity of the BCT, Fires, and MEB BSB does not meet the daily requirement of the brigades. The table below further outlines the water shortfall.

Type Unit	End Strength ³⁶	Planning Factor	Daily Requirement	Daily Capacity	Daily Shortfall
BCT	3500	13 G/M/D	45.5K	33K	12.5K
CAB	2678	13 G/M/D	34.8K	33K	1.8k
Fires	3000	13 G/M/D	39K	33K	6K
MEB	N/A; no BSB FY13	N/A; no BSB FY13	N/A; no BSB FY13	N/A; no BSB FY13	N/A; no BSB FY13
BFSB	1340	13 G/M/D	17.4K	33K	No Shortfall

Figure 1. Shortfalls

The shortfalls depicted in Figure 1 only take into account the organic end-strength of the actual brigades. The BSB is also required to provide water support for captured enemy combatants, contractors, attached, OPCON, or TACON organizations. Furthermore, while both OPCON and TACON command relationships imply that the BCT and therefore, the BSB, does not have support responsibility to these units; the reality on the battlefield is the BSB will provide water support for these elements.³⁷ This additional support requirement further exacerbates the water production shortfall. Moreover, the BSB may have yet more doctrinal requirements to provide water support to other units on an area support basis. “If the EAB units are in the brigade AO and the number of personnel and items of equipment to be supported are small enough, the BSB supports them on an area basis.”³⁸ Whether BSB supports the EAB units

operating in the BCT AO on area basis or helps the unit coordinate support from the Sustainment Brigade's CSSB is immaterial.

The fact is as, currently configured; the BSB does not have the capacity to produce enough water on a daily basis to support its BCT organic customer base. Logistics requirements beyond the BSB's capabilities or capacities "are either furnished by or coordinated through the supporting sustainment brigade."³⁹ The BSB coordinates with the SBDE to alleviate its water-production shortfall requirement. The SBDE then tasks its subordinate CSSB(s) to provide a daily push of bulk water via truck to the BCT or to provide a water team to augment the BSB's water production capability.

In order to reduce line-haul truck requirements, make the most efficient use of the DBL system, and produce water as close as possible to the user, the optimal means of meeting the BSB's water production shortfall is to augment water purification. The BSB can coordinate with the SBDE Support Operations to provide the augmentation. The SBDE would task the CSSB to provide the required augmentation from its assigned Modular Quartermaster Water Purification and Distribution Company.⁴⁰

There is one, active-duty water purification and distribution company in the Army. This company with its modular water purification and distribution platoons provides "tailored water production package capabilities, storage, and bulk area distribution at the operational and tactical levels."⁴¹ Each BCT operating in an arid environment will require, at a minimum, a TWPS water purification team to meet the BCT's daily requirement. The augmenting TWPS water team increases the BSB's daily production capacity to 63K per day. Figure 2 below demonstrates the change upon providing the additional modular water production team to the BSB.

Type Unit	End Strength ⁴²	Planning Factor G/M/D	Daily Requirement	Daily Capacity	Excess Capacity
BCT	3500	13	45.5K	63K	17.5K
CAB	2678	13	34.8K	63K	28.2k
Fires	3000	13	39K	63K	24K
MEB	N/A; no BSB FY13	N/A; no BSB FY13	N/A; no BSB FY13	N/A; no BSB FY13	N/A; no BSB FY13
BFSB	1340	13	17.4K	33K	15.6K

Figure 2. Reinforcing Capacity

It also shows the excess capacity generated by augmenting the BSB with a water production team. This excess capacity will enable the BSB to meet the additional water requirements for area support and or additional command-and-control relationship units previously discussed. Additionally, the excess, depending upon supported population, enables the BSB to provide supply-point water distribution for other services or coalition forces.

In addition to water production augmentation to support the increased water requirement, the BSB also needs water distribution augmentation to support the increased distribution flow to supported units. Water distribution is the metered flow from supporting unit to supported unit and ultimately to individual Soldier. Field Manual 4-90, *Brigade Support Battalion*, describes this flow in terms of combat loads distributed through Logistics Packages (LOGPACs) to Logistics Release Points (LRPs) from supporting units to supported units.⁴³ The BCT and Support Brigades continuously

maintain three combat loads: one at the organizational unit, one at the Forward Support Company (FSC), and one at the BSB.⁴⁴ The SBCT is the exception to this structure. The SBCT does not have FSCs. The SBCT increased water distribution capability at the BSB and unit levels.⁴⁵ Each echelon conducts a daily push of a single combat load to an LRP to resupply the lower echelon to ensure the continuous flow of water to the end user.

The use of the vague term “combat load” does not apply the science and mathematics to determine the actual, daily water requirement expressed in gallons per day, especially in an arid and austere environment. Rather, the terminology assumes the organizational and BSB elements can meet the requirement to distribute a combat load. Determining the actual, daily requirement is critical at the unit level; if incorrect, Soldiers suffer.

At the unit level, the primary means to store and distribute water to the individual Soldier is the trailer-mounted, 800-gallon water tank, Unit Pod System (Camel).⁴⁶ This system is already replacing the trailer-mounted, 400 gallon M107, M149, M1112 series Water Trailer (Water Buffalo).⁴⁷ The basis of issue for this Camel is one per company. The infantry companies of the SBCT have two Camels per company, to alleviate the lack of an FSC to support the infantry battalions. Figure 3 below provides an evaluation of organizational units’ capability to meet the daily water requirement of its Soldiers.

Unit	End Strength ⁴⁸	Daily Requirement	Capacity	Number of Daily refills required
IBCT – Inf Co	131	1,703	1 Camel = 800	2+
IBCT – FA Btry	94	1222	1 Camel = 800	2
HBCT – Inf Co	136	1768	1 Camel = 800	2+
HBCT – AR Co	64	832	1 Camel = 800	1+
SBCT – Inf Co	166	2158	2 Camels= 1600	1+
SBCT – FA Btry	90	1170	1 Camel = 800	1+

Figure 3. Capacities

Figure three, using the end strengths and capabilities discerned from the Army's Tactical Wheeled Vehicle study, clearly indicates the storage and distribution capacities of the selected units do not meet the daily Soldier requirement.⁴⁹ At the unit level, Company 1SGs and Supply Sergeants have to conduct at least two water replenishment operations using their organic camels every day. The IBCT and HBCT infantry companies require three replenishment operations. In fact, any company with an end strength greater than 61 soldiers and having only one organic Camel assigned has to conduct more than one water replenishment operation everyday in an austere and arid environment.

The preferred method of water replenishment, as previously indicated, is via the daily LOGPAC at a designated LRP.⁵⁰ According to Field Manual 4-90, *Brigade Support*

Battalion: August 31, 2010, the FSC “distribute[s] to the units they support as part of the resupply operations.”⁵¹ However, according to Field Manual Interim (FMI) 4-93.2, *The Sustainment Brigade: February 4, 2009*, “FSCs within BCTs do not have water support capability” and “water will be issued using supply point distribution from FSCs.”⁵² This contradiction between two doctrinal logistics manuals is critical.

Field Manual 4-90, *Brigade Support Battalion; August 31, 2010*, assumes that FSCs have the requisite number of Load Handling System Compatible Water Tank Rack System (Hippo) within its fuel distribution section to conduct water supply support during replenishment operations.⁵³ Field Manual Interim 4-93.2, *The Sustainment Brigade*, correctly determines no water support capability in the FSC. The Army's *Tactical Wheeled Vehicle Study* that clearly indicates that there is no mobile water distribution capability in the FSC and supports FMI 4-93.2, *The Sustainment Brigade; February 4, 2009*.⁵⁴

In order to conduct water replenishment operations at the unit level, the FSC must synchronize replenishment operations to supported company level using the BSB Hippos for water replenishment. Otherwise the FSC must conduct water replenishment operations using supply-point distribution with a combination of its single Forward Area Water Point Supply Systems (FAWPSS) and staged Hippos from the BSB. The FSC's FAWPSS does not have the storage capacity to meet the supported units' requirements. Supply-point distribution assumes that BSB has both the time and number of Hippos required to support supply point operations and still conduct water replenishment operations to four FSCs.

The BSB's primary means to conduct water distribution operations is the Hippo. Doctrinally the BSB conducts water distribution to its subordinate FSCs, or in the case of SBCT's to maneuver battalions, during daily replenishment operations.⁵⁵ LOGPAC water distribution assumes that the BSB's Hippos have the capacity to meet the daily requirement conducting two trips per day. "Ideally, the BSBs should be from 30 KM to 45 KM from combat operations and the FSCs should be from 4 KM to 15 KM from combat."⁵⁶ These doctrinal distances, enable the local-haul capability to conduct two lifts per day. However, in the projected, decentralized, and dispersed battlefield with extended LOCs previously discussed, the listed doctrinal distances are mere guidelines and not rules.

Type Unit	# of BSB Hippos ⁵⁷	Single Lift Capacity	Daily Requirement	# of lifts Required
H&IBCT	6 ⁵⁸	12K	45.5K	3+
SBCT	10 ⁵⁹	20K	45.5K	2+
CAB	6 ⁶⁰	12K	34.8K	2+
Fires	6 ⁶¹	12K	39K	2+
BFSB	4 ⁶²	8K	17.4K	2+

Figure 4. Lifts Required

Figure four above assumes the BSB is within doctrinal distance to execute two lifts per day using its organic Hippos, and conduct water distribution during replenishment operations. All of the brigades listed in the figure are incapable of executing water distribution operations using only organic assets. All of the brigades require distribution augmentation. The figure and estimates in the figure do not include

the additive requirements for attached or Operational Control (OPCON) units, required support for detainee operations, Displaced Personnel, Contractors, and area support for EAB units operating in the brigade's AO.

Just like water production operations, the BSB has to coordinate with the SBDE to provide reinforcing augmentation from the CSSB Water Purification and Distribution Company. The distribution augmentation comes from the Modular Storage and Distribution Platoon attached to the CSSB's attached Water Purification and Distribution Company.⁶³

The Modular Storage and Distribution Platoons consist of a platoon headquarters and storage, distribution, and maintenance sections. The distribution section has seven Palletized Load System (PLS) trucks with trailers and fourteen Hippos for distribution operations. The figure below depicts the augmentation requirements to support the BCTs' and support brigades' distribution shortfalls.⁶⁴

Type Unit	Daily Req	BSB Capability	Delta	Hippos Req
IBCT	45.5K	24K	21.5K	11
HBCT	45.5K	24K	21.5K	11
SBCT	45.5K	40K	5.5K	3
CAB	34.8K	24K	10.8	6
Fires	39K	24K	15K	8
BFSB	17.4K	16K	1K	NA
			Total:	39

Figure 5. Augmentation Requirements

A three-BCT operation with a CAB, Fires Brigade, and BfSB, requires thirty-nine additional Hippos to meet the daily water distribution needs or the equivalent of 2.7 distribution sections. Each water storage and distribution platoon has one water section and there are only two, active-duty, modular water distribution platoons and only one, active-duty water production and storage company.⁶⁵ Using the distribution sections would render both the platoon and company incapable to execute their primary mission to provide water distribution to EAB units in contingency operations.

A solution is for the Army to provide the reinforcing distribution support using assets from the Medium Truck Co (PLS) (EAB Tactical). The Medium Truck Company (PLS) is normally attached to a CSSB and provides the primary line-haul lift of all classes of supply from the CSSB to BCTs, Support Brigades and Functional Support Brigades forward of the CSSB. The BSBs request the reinforcing assets from the SBDE, who then tasks the CSSB to provide the assets as an attached or OPCON element to meet the daily requirement.

Providing these assets in direct support to a brigade in an attached or OPCON command relationship negates the dual-use capability of the trucks to provide dry and wet containerized cargo line-haul. Additionally, the CSSB's ability to conduct DBL across the breadth and depth of the battlefield reduces a portion of its cargo-hauling assets by dedicating the cargo-hauling assets to a specific mission for specific units. The capability reduction to provide reinforcing water production and distribution to the brigade level significantly affects support at the EAB level.

Water Production and Distribution at the EAB level

At the EAB level, the MEB, SBDE, functional support brigades, Division, Corps and Theater Headquarters and their supporting enabling units do not have organic

water production and distribution capabilities. The EAB units listed above receive water production support from the Modular Water Purification and Distribution Company and the Augmentation Water Support Company for arid environments.⁶⁶ “The Quartermaster Water Purification and Distribution Companies and Augmentation Water Support Companies are assigned to CSSBs in Sustainment Brigades.”⁶⁷

The Water Purification and Distribution Company with its subordinate assigned modular water production platoons and storage and distribution platoons provide 360K gallons of water per day to support EAB units on an area basis.⁶⁸ Additionally, the company provides the reinforcing support to the brigades. The 360K gallons of water assumes two production platoons assigned to the company.⁶⁹

In FY13 the Army will reduce the number of active-duty water purification and distribution companies from two to one, production platoons from eight to six, and storage and distribution platoons from four to two.⁷⁰ This reduction significantly degrades the active-army’s capability to provide critical water purification and distribution for contingency operations in an austere, arid environment to EAB units and reinforcing water support to brigades. Additionally, the decrease in active-duty capability makes the Army reliant on the Reserve Component (RC) to provide water purification and distribution for any contingency operation that requires more than seven BCTs and the associated command and control enablers. The figure below depicts the reinforcing and EAB requirements for a seven BCT, with two division HQs and the associated enablers, contingency operation in an austere, arid environment.

Type Unit	End Strength	Daily Water Requirement	Organic Capability	Reinforcing or Area support req.
IBCT x 7	24,500	318.5	231K	87.5K
CAB x 2	5,356	69.6K	66K	3.6K
Fires Bde x 2	6,000	78K	66K	12K
BFSB x 2	2,680	34.6K	66K	-31.2K
MEB x 2	6,800	88K	NA	88K
SBDE x 2	23,622	308K	NA	308K
Div Hqs and enablers x 2	41,452	538K	NA	538K
Totals:	110,410	1,434.7K	429K	1,005.9K

Figure 6. Reinforcing and EAB Requirements

The operation depicted above would require all six active-duty water purification platoons to meet the daily water requirement. The six platoons can produce a total of 1.08M gallons of water a day. The figure depicts the daily requirement at 1.005M gallons of water a day leaving a surplus of 74K gallons of water. As demonstrated earlier, the reinforcing water purification at the BCTs results in a surplus of 17.5K per BCT for a total surplus of 122.5K. The BCTs use this surplus to support coalition, other service, detainees, and displaced persons in accordance with the Army's requirement as the water Executive Agent.⁷¹ However, this macro view of these planning factors implies that all water production proceeds efficiently across the breadth and depth of the battlefield.

Figure 6 only depicts the requirements to sustain BCTs, Support Brigades, and EAB elements to include two division-level headquarters. Most critically, the figure demonstrates the Army uses all of its active-component water purification capability to support the depicted contingency operation and the estimate for this operation does not include the water support requirements for the additional forces to either command and control two divisional headquarters or sustain the force from the sustainment base at the port forward. The additional forces may include a Theater or Corps headquarters, a Theater Sustainment Command (TSC) or Expeditionary Sustainment Command (ESC) and the TSCs or ESCs subordinate theater-level SBDE, CSSBs, and Functional Sustainment Battalions.

Any operation requiring more than an estimated seven BCTs, the associated command-and-control and support structure to direct and sustain operations, requires RC forces to achieve the daily water support requirement. The Army is taking extreme risk in its reliance on the RC to provide water purification and distribution to sustain its forces in contingency operations. Given current mobilization policy and processes, RC units require 90-120 days to mobilize and deploy, significantly degrading the Army's ability to conduct short-notice contingency operations.⁷²

The Army RC has sixteen water purification companies with twenty-five modular purification platoons. Each of these platoons can purify 180K gallons of water a day. The platoon's modular design enables their dispersion across the battlefield as close to the point of use as possible.⁷³

The RC also has six Augmentation Water Companies with two purification platoons and water storage platoons assigned. Each Augmentation Water Company

purifies 720K and stores 1.9M gallons of water a day. The Water Augmentation Company is a theater asset assigned to the “CSSB (Theater).” The Augmentation Water Company requires line-haul distribution of its stored water to using units. The company does not have the organic capability to conduct line-haul distribution.⁷⁴

At the SBDE, the Army relies on the Medium Truck Company (PLS) to provide “ground transportation of dry and refrigerated containerized cargo, other break bulk cargo and when equipped with Hippos bulk water transport”⁷⁵ for EAB units. The Medium Truck Company (PLS) is assigned to the TSC and attached to the CSSB.⁷⁶ The Medium Truck Company (PLS) is a multi-purpose, ground-transport unit that enables the CSSB to move all classes of supply, to include bulk water to the CSSB’s supported units.

Using the estimates from Figure 6, the Army requirement for the ground distribution of bulk water is 1,005K gallons of water every day. The Medium Truck Company (PLS) is capable of moving 240K gallons of water in its line haul mission. The Army requires four of the thirteen active-component Medium Truck Company (PLS) truck companies dedicated for daily water distribution.

Dedicating thirty percent of the available active-component Medium Truck Company (PLS) ground transport for bulk water distribution significantly degrades the Army’s ability to transport all other classes of supply. As a result, any operation requiring more than seven BCTs and the associated C2 and EAB units require the mobilization of RC Medium Truck Company (PLS) truck companies to sustain water distribution and provide the metered flow of all other supply requirements for successful DBL operations.

The Army also relies on Medium Truck Companies (PLS) to provide line-haul bulk water distribution. This company is a theater-level asset assigned to the TSC and attached to either a Transportation Motor Transport Battalion or CSSB (Theater). The Medium Truck Company (Cargo) is a multi-purpose asset providing “transportation for the movement of containerized, non-containerized, palletized, dry and/or refrigerated containerized cargo and bulk water products.”⁷⁷ The Medium Truck Company (Cargo) provides the capability to transport 240K gallons of water in a single line-haul lift.⁷⁸

The Augmentation Water Company relies on the Medium Truck Company for distribution of the water it purifies and stores. As discussed earlier the Augmentation Water Company purifies 720K gallons of water a day. To transport this daily purification rate requires three of the four available active-component Medium Truck Companies or seventy-five percent of the available active-component assets.⁷⁹

The Army has taken significant risk in placing nearly ninety percent of its EAB water purification and eighty-four percent of its EAB transportation capabilities in the RC.⁸⁰ In both Operation Iraqi Freedom and Operation Enduring Freedom, the Army has mitigated the shortfall in water purification units through a complete reliance on bottled water for personal consumption. Additionally, the Army has mitigated its shortfalls in transportation capacity through extensive contracted and host-nation support. In future contingency operations, in austere, arid environments with extended, non-contiguous LOCs, the Army cannot afford to take this risk.

Recommendations

The first and most critical recommendation is make the BCTs and Support Brigades self sufficient for water purification and distribution. Adding an additional TWPS to the BSB’s water section enables the BSB to meet its supported brigade’s daily

water requirements even in an austere, arid environment. Increasing the purification capacity also meets the intent of producing water as close as possible to the user. By recapitalizing the TWPS from the government furnished equipment (GFE) used by contractors in Iraq and Afghanistan, the Army can meet the additional BSB requirement without purchasing new equipment. Additionally, the BSB water section already has the required manpower to operate two TWPS in tandem, negating the need to increase personnel.

For distribution, the Army should increase the BSB's Hippos and the associated PLS and trailer system from six to twelve, enabling the BSB to meet its daily water distribution requirement. Additionally, equip the BSB's subordinate FSCs with three Hippo systems, three PLS and trailers and six Hippos, enabling the FSC to conduct mobile water storage and distribution and providing the FSC and BSB flexibility in water distribution. Finally, increase the number of Camels at the company level from one to three. The increase of Camels would enable the companies to conduct a single, daily water replenishment operation rather than the multiple water replenishment operations currently required.

Although equipping the FSCs with Hippo Systems and increasing the number of Camels in each company would generate an expenditure of Army funding, the cost savings to eliminate the use of bottled water makes up the expenditure over time. Additionally, making the brigades self-sufficient for both production and distribution significantly reduces the motor-transport requirement at the brigade level. Finally, making the brigades self-sufficient eliminates the requirement for the Water Purification

and Distribution Company to provide reinforcing support to the brigades, increasing the company's ability to provide the critical area support for EAB.

The second recommendation is the Army should not execute the plan to decrease the number active-duty water purification and distribution companies from two to one in FY13. The second water purification and distribution company provides the active force with flexibility to conduct a "large-scale operation in one region" and still be "capable of denying the objectives of-- or imposing unacceptable costs on-- an opportunistic aggressor in another region."⁸¹ Additionally, having the second company with its associated purification and distribution platoons enables the Army to conduct contingency operations and provide the time to mobilize, train, and deploy RC water purification and distribution companies on a rotational basis with the Active-Component companies.

The final recommendation is to add two augmentation purification platoons to the Active-Component. Adding these two platoons would provide the Army with increased purification capabilities to meet the increased water support requirements at the EAB level in an austere, arid environment. Additionally, these platoons would significantly reduce the reliance on bottled water at the EAB level and enable the army to meet the guidance outlined by Secretary Panetta's quote in the previous paragraph.

Conclusion

In conclusion, the current active-duty water purification and distribution system from the brigade to EAB level is incapable to meet the daily water support requirements of the force to conduct contingency operations in an austere and arid environment. The BCTs would require reinforcing support from EAB water purification and distribution units to meet the daily water support requirement. Active-duty EAB water purification

units lack the capacity to provide both that reinforcing support and meet the area-support mission requirements for EAB units from the theater to the BCT. Finally, the Army has accepted considerable risk for any operation requiring more than seven BCTs and enablers by relying on RC water purification and distribution to make up for the active-duty shortfall.

The AC's inability to meet its forces' daily water support requirements paints a dismal picture to meet the vision of providing sustained, bulk potable water support for contingency operations as discussed above. Additionally, because the Army is incapable to provide a sustained, metered flow of bulk water within the DBL process, the Army will continue to rely on bottled water for consumption at a cost of \$27.9M a year for every BCT.

However, the Army is capable to reconfigure its assets to meet the forces' requirements for bulk water and rethink its plan to inactivate active-duty water-support units. Recapitalizing returning water purification equipment from Iraq and Afghanistan and increasing the distribution capabilities in the BCTs will create self-sufficient BCTs. A self-sufficient BCT negates the need for bottled water and reinforcing support requirements.

At EAB level, terminating the planned inactivation of active-duty water-support units would provide the ability of EAB, active-duty water units to provide bulk water support, eliminating the need for bottled water. Additionally, retaining the active-duty EAB water-support units creates the flexibility and time to mobilize and deploy RC units. This retention would reduce the transportation requirement, increasing the capability to move other supplies in the DBL process.

Finally, making the BCTs self-sufficient, recapitalizing on returning equipment, and increasing the EAB water support units, the Army can meet its water support requirements. The Army will also meet Secretary of Defense Panetta's guidance for future operations. The Army can become a good steward of the nation's fiscal resources by eliminating the need for bottled water. Providing the Army with a "logistics network capable of projecting and providing the support and services necessary to ensure freedom of action, extend operational reach, and prolong endurance", this requires the Army to invest in certain force structures.⁸²

Endnotes

¹ U.S. Department of the Army, *Combined Operations in Urban Terrain*, Field Manual 3-06.11 (Washington, DC: U.S. Department of the Army, February 28, 2002), 13-14.

² Ibid., 5.

³ U.S. Joint Chiefs of Staff, *Joint Bulk Petroleum and Water Doctrine*, Joint Publication 4-03 (Washington DC: U.S. Joint Chiefs of Staff, December 9, 2010), xxii.

⁴ Kent Hughes Butts, "The Strategic Importance of Water Online," *Parameters*, (Spring 1997): 67. <http://www.carlisle.army.mil/usawc/parameters/Articles/97spring/butts.htm> (accessed December 28, 2011), 13, 67.

⁵ Ibid. 13, 67.

⁶ Ibid., 13.

⁷ U.S. Department of the Army, *The United States Army Operating Concept 2016-2028*, Training and Doctrine Command Pamphlet 525-3-1 (Washington DC: U.S. Department of the Army, August 19, 2010), 9.

⁸ Ibid. 4.

⁹ U.S. Department of the Army, *The United States Army Functional Concept for Sustainment: 2016-2028*, Training and Doctrine Command Pamphlet 525-4-1 (Washington DC: U.S. Department of the Army, October 13, 2010), iii.

¹⁰ U.S. Department of the Army, *Unified Land Operations*, forward by GEN Raymond Odierno

¹¹ Ibid., 6.

¹² Ibid., 14.

¹³ Eric Peltz, John M. Halliday, Marc L. Robbins, Kenneth J. Girardini, *Sustainment of Army Forces in Operation Iraqi Freedom: Battlefield Logistics and Effects on Operations – Prepared for the United States Army*, xi.

¹⁴ U.S. Department of the Army, *The United States Army Functional Concept for Sustainment: 2016-2028*, Training and Doctrine Command Pamphlet 525-4-1 (Washington DC: U.S. Department of the Army, October 13, 2010), 19.

¹⁵ Donald J. Atwood, Deputy Secretary of Defense, “Department of Defense Directive 4705.1” (Subject: Management of Land-Based Water Resources in Support of Contingency Operations), Washington DC: Department of Defense, July 9, 1992.

¹⁶ Ibid., 2.

¹⁷ U.S. Department of the Army, *Water Supply in Theaters of Operations*, Field Manual 10-52 (Washington, DC: U.S. Department of the Army, July 11, 1990), 2-1.

¹⁸ U.S. Department of the Army, *The United States Army Functional Concept for Sustainment: 2016-2028*, 13.

¹⁹ Lt. Col. Rick Ellis, “SRC 10 (Quartermaster) SRC 42 (Supply) Headquarters Department of the Army G-3/7 Force Modernization, Total Army Analysis 14-18 Rules of Allocation” Director Force Management Brief, June 24, 2010.

²⁰ Ibid., June 24, 2010.

²¹ U.S. Department of the Army, *Water Supply in Theaters of Operations*, 3-5.

²² U.S. Joint Chiefs of Staff, *Joint Bulk Petroleum and Water Doctrine*, VI-4.

²³ Ibid., VI-4.

²⁴ Force Development Directorate, *Water Planning Guide*, Force Development Directorate (Fort Lee, VA: United States Army Combined Arms Support Command, November 25, 2008), I-8.

²⁵ Fred Lash, “Marines Take Steps to Avoid Costly Bottled Water Resupply,” online *National Defense Magazine*, May 2011, 2.
<http://www.nationaldefensemagazine.org/archive/2011/May/Pages/MarinesTakeStepstoAvoidCostlyBottledWaterResupply.htm> (accessed January 29, 2012).

²⁶ John H. Klie and Stephen Rome, “US Army Reduces Water Costs with Mobile Purifier Units,” October 24, 2011, <http://www.waterworld.com/index/display/article-display/241200/articles/water-wastewater.htm> (accessed January 29, 2012).

²⁷ Donald J. Atwood, Deputy Secretary of Defense, “Department of Defense Directive 4705.1 (Subject: Management of Land-Based Water Resources in Support of Contingency Operations), Washington DC: Department of Defense, July 9, 1992.

²⁸ Ibid., 1-1.

²⁹ Ibid., 1-9.

³⁰ Col (Ret.) John Bonin, Director, Concepts and Doctrine, United States Army War College, interview by author, Carlisle, PA January 17, 2012.

³¹ U.S. Department of the Army, *Brigade Support Battalion*, Field Manual 4-90 (Washington DC: Department of the Army, August 31, 2010), 1-9.

³² Ibid., 3-6.

³³ Ibid., 3-6.

³⁴ U.S. Department of the Army, *The United States Army Functional Concept for Sustainment: 2016-2028*, 13.

³⁵ U.S. Department of the Army, *Brigade Support Battalion*, 3-7.

³⁶ Col (Ret.) John Bonin, interview with Author, January 17, 2012.

³⁷ U.S. Department of the Army, *Water Supply in Theaters of Operation*, 3-3.

³⁸ U.S. Department of the Army, *Brigade Support Battalion*, 2-12.

³⁹ Ibid., 1-6.

⁴⁰ U.S. Department of the Army, *The Sustainment Brigade*, Field Manual Interim 4-93.2 (Washington, DC: Department of the Army, February 4, 2009), 4-9.

⁴¹ Ibid., 4-9.

⁴² Col (Ret.) John Bonin, interview with Author, January 17, 2012.

⁴³ U.S. Department of the Army, *Brigade Support Battalion*, 3-6.

⁴⁴ Ibid., 3-6.

⁴⁵ No Author, "Stryker Brigade Combat Team, Tactical Wheeled Vehicle Study," briefing slides, Washington DC: The Pentagon, March 25, 2009.

⁴⁶ U.S. Department of the Army, *Army Modernization Plan 2012*, (Washington DC: Department of the Army, May 24, 2011), 47.

⁴⁷ Ibid., 47.

⁴⁸ Col (Ret.) John Bonin, interview with Author, January 17, 2012.

⁴⁹ No Author, "Heavy and Infantry Brigade Combat Team, Tactical Wheeled Vehicle Study," briefing slides, Washington DC: The Pentagon, March 25, 2009.

- ⁵⁰ U.S. Department of the Army, *Brigade Support Battalion*, 3-6.
- ⁵¹ Ibid., 3-6.
- ⁵² U.S. Department of the Army, *The Sustainment Brigade*, 4-10.
- ⁵³ U.S. Department of the Army, *Army Modernization Plan 2012*, 47.
- ⁵⁴ No Author, "Heavy and Infantry Brigade Combat Team, Tactical Wheeled Vehicle Study," briefing slides, Washington DC: The Pentagon, March 25, 2009.
- ⁵⁵ U.S. Department of the Army, *Brigade Support Battalion*, 3-6.
- ⁵⁶ U.S. Department of the Army, *The Sustainment Brigade*, 2-11.
- ⁵⁷ No Author, "Stryker Brigade Combat Team, Heavy Brigade Combat Team, and infantry Brigade Combat Team, Tactical Wheeled Vehicle Study," briefing slides, Washington DC: The Pentagon, March 25, 2009. TWV
- ⁵⁸ No Author, "Heavy and Infantry Brigade Combat Team, Tactical Wheeled Vehicle Study," briefing slides, Washington DC: The Pentagon, March 25, 2009.
- ⁵⁹ No Author, "Stryker Brigade Combat Team, Tactical Wheeled Vehicle Study," briefing slides, Washington DC: The Pentagon, March 25, 2009.
- ⁶⁰ U.S. Department of the Army, *Aviation Brigades*, Field Manual 3-04.111 (Washington DC: Department of the Army, December 7, 2007), 5-20.
- ⁶¹ U.S. Department of the Army, *Brigade Support Battalion*, 3-6.
- ⁶² U.S. Department of the Army, *Battlefield Surveillance Brigade*, Field Manual 3-55.1 (Washington DC: Department of the Army, June 14, 2010), 7-13.
- ⁶³ Lt. Col. Rick Ellis, "SRC 10 (Quartermaster) SRC 42 (Supply) Headquarters Department of the Army G-3/7 Force Modernization, Total Army Analysis 14-18 Rules of Allocation" Director Force Management Brief.
- ⁶⁴ Ibid., unnumbered slide.
- ⁶⁵ Ibid., unnumbered slide.
- ⁶⁶ U.S. Department of the Army, *The Sustainment Brigade*, 4-9.
- ⁶⁷ Ibid., 4-9.
- ⁶⁸ Ibid., 4-9.
- ⁶⁹ Lt. Col. Rick Ellis, "SRC 10 (Quartermaster) SRC 42 (Supply) Headquarters Department of the Army G-3/7 Force Modernization, Total Army Analysis 14-18 Rules of Allocation" Director Force Management Brief.

⁷⁰ Ibid., unnumbered slides.

⁷¹ Donald J. Atwood, Deputy Secretary of Defense, “Department of Defense Directive 4705.1 (Subject: Management of Land-Based Water Resources in Support of Contingency Operations), Washington DC: Department of Defense, July 9, 1992.

⁷² Eric Peltz, John M. Halliday, Marc L. Robbins, Kenneth J. Girardini, *Sustainment of Army Forces in Operation Iraqi Freedom: Battlefield Logistics and Effects on Operations – Prepared for the United States Army*, 23.

⁷³ Lt. Col. Rick Ellis, “SRC 10 (Quartermaster) SRC 42 (Supply) Headquarters Department of the Army G-3/7 Force Modernization, Total Army Analysis 14-18 Rules of Allocation” Director Force Management Brief.

⁷⁴ Ibid., unnumbered slides.

⁷⁵ No Author, “SRC 55 – Transportation Headquarters Department of the Army G-3/7 Force Modernization, Total Army Analysis: Transportation Rules of Allocation” Director Force Management Brief, Washington DC: The Pentagon, June 7, 2010., 62.

⁷⁶ Ibid., 62.

⁷⁷ Ibid., 27.

⁷⁸ Ibid., 27.

⁷⁹ Ibid., 27.

⁸⁰ LTC Rick Ellis, “SRC 10 (Quartermaster) SRC 42 (Supply) Headquarters Department of the Army G-3/7 Force Modernization, Total Army Analysis 14-18 Rules of Allocation” Director Force Management Brief. Unnumbered Slides . And No Author, “SRC 55 – Transportation Headquarters Department of the Army G-3/7 Force Modernization, Total Army Analysis: Transportation Rules of Allocation” Director Force Management Brief, Washington DC: The Pentagon, June 7, 2010., 62.

⁸¹ Leon Panetta, Secretary of Defense, “Sustaining U.S. Global Leadership: Priorities for the 21st Century Defense” (Washington DC: Department of Defense, January 5, 2012), 4.

⁸² U.S. Department of the Army, *The United States Army Functional Concept for Sustainment: 2016-2028*, Training and Doctrine Command Pamphlet 525-4-1 (Washington DC: U.S. Department of the Army, October 13, 2010), iii

